Ozone Student Activity Book

*** For ease of use during class, the teacher key pages are numbered the same as the student book pages ***

I. Introduction

Ozone is similar to oxygen that we breathe. Air contains oxygen molecules which are made up of two oxygen atoms combined together (O_2). Ozone is a molecule made of three oxygen atoms combined together (O_3). Ozone is everywhere in our atmosphere, but most of it is at the altitude that airplanes fly. It is poisonous if inhaled, but it also shields us from ultraviolet (UV) light that would give us skin cancer. Ozone is therefore one of those things that we can't live with and can't live without, but if it's in the right place, it does us a great service. Naturally, there is very little ozone at ground level, and very much of it in the upper atmosphere. Start the activity to learn more about ozone's effects.

Get Info Objectives

1. Describe where the ozone layer is.
2. Explain natural formation of ozone.
3. Explain how CFCs destroy ozone.

Gather Data Objectives

1. Interpret graphs of ultraviolet radiation, ozone concentration, and chlorine concentration.
2. Explain why artificial chemicals are more destructive to ozone than are naturally occurring chemicals.
3. Describe ozone's harmful effects at ground level.

Application Objectives

1. Describe the economic effects on people affected by ozone depletion.
2. Describe economic effects of banning CFCs.
3. Justify international ozone-related laws.

- From the main screen, click "Get Info."

II. Get Info

A. Location of Ozone

- Click on the "Aeronomy Lab" site.
- Scroll down to page two.
- Read the information, interpret the picture, and answer the following question.

1. Where is the ozone layer ?

The stratosphere contains the ozone layer

- Click "Back" to get back to the OAR Ozone Get Info site.

B. Ozone Loss

- Click on the "Ozone Depletion" site.
- Read the site and answer the following questions.

1. What does CFC stand for?

chlorofluorocarbons

2. What were CFCs used for?

propellants in spray cans, refrigerants, electronics cleaning agents, foam, and insulating products

3. What are three chemical properties of CFCs?

chemical inertness (won't react with other chemicals), non-toxic, insoluble in water

4. What specific atom of the CFC molecule damages ozone?

The chlorine atom does the damage.

- Click "Back" to get back to the OAR Ozone site main screen.
- Click "Gather Data."

III. Gather Data

A. Ozone Eaters

- Click on the "Common Questions" site.

1. How is ozone distributed in the atmosphere?

90% stratosphere, 10% troposphere

2. What is the "ozone hole"?

The decrease in the amount of stratospheric ozone over the Antarctic of up to 60% in ozone concentration is called the ozone hole.

3. Besides CFCs, what other molecules destroy ozone?

Halocarbons (Chlorine, Fluorine, Bromine, Carbon, Hydrogen) in combinations can destroy ozone.

- Click "Back" to get back to the OAR Ozone Gather Data site.

B. Proof of Damage

- Click on the "Evidence" site.
- Look at the figure and answer the following question.

1. As the concentration of chlorine rises, what happens to the concentration of ozone?

The concentration of ozone decreases.

- Click "Back" to get back to the OAR Ozone site.

C. Natural vs. Artificial

- Click on the "Chlorine Sources" site.

1. Since nature produces chlorine all the time, why do only artificially produced chlorine molecules cause trouble?

Those molecules that will dissolve in water don't make it to the stratosphere because they are absorbed by rain, snow, or ice.

2. What percent of the chlorine in the stratosphere can be attributed to nature? 18%

- Click "Back" to get back to the OAR Ozone Gather Data site.

- Click "Forward" at the bottom of the screen.

D. Total Ozone Loss

- Click on the "October Ozone Hole" site.
- Scroll down to the graph.

1. Compute the percentage of ozone in Antarctica in 1993 compared to the amount of ozone we had in October in 1957.

- Estimate the total ozone in 1957 and record it below.
  330 Dobson units

- Estimate the total ozone in 1993 and record it below.
  145 Dobson units

- Divide the 1993 value by the 1957 value.
- Move the decimal two places to the right to get the percentage of ozone that we have now.

145 ÷ 330 = .439 = 44%

- Click "Back" to get back to the OAR Ozone Gather Data site.

E. Sunburn Effects

- Click on the "Ultraviolet Radiation" site.

1. If the concentration of ozone decreases 30%, how much additional UV radiation will reach the surface of the earth?

   _____

- Click "Back" to get back to the OAR Ozone Gather Data site.

50%

F. Future Outlook

- Click on the "Ozone Treaty" site.

1. What is expected to happen to the ozone layer during your lifetime?

The ozone layer is expected to slowly return to normal by the middle of the twenty-first century (2050).

- Click "Back" to get back to the OAR Ozone Gather Data site.

G. Unusual Suspect

- Click on the "Rural Ozone" site.

1. What problems are associated with ozone at ground level?

Severe damage to plants and animals occurs due to ozone.

2. How are we producing ozone at ground level?

VOCs (volatile organic compounds) like methane react with nitrogen containing compounds from power plants and car exhaust to produce ozone.

3. How can we decrease the ozone concentrations at ground level?

Decreasing the amount of nitrogen compounds released by cars and power plants will decrease the tropospheric ozone concentration.

4. What changes in our lives can we make to reduce ozone concentrations at ground level?

Answers could include the following: drive fewer miles in cars, car pool, ride buses, conserve electricity so the power plants don't have to produce as much power

- Click "Back" until you get back to the OAR Ozone site main screen.
- Click "Application."

IV. Application

A. Economic Problems

- Click on the "Health" site.
- Read the site, think about the impacts of ozone depletion and answer the following question.

1. Describe the economic effects on people affected by ozone depletion. Include medical problems in humans, crops, and livestock.

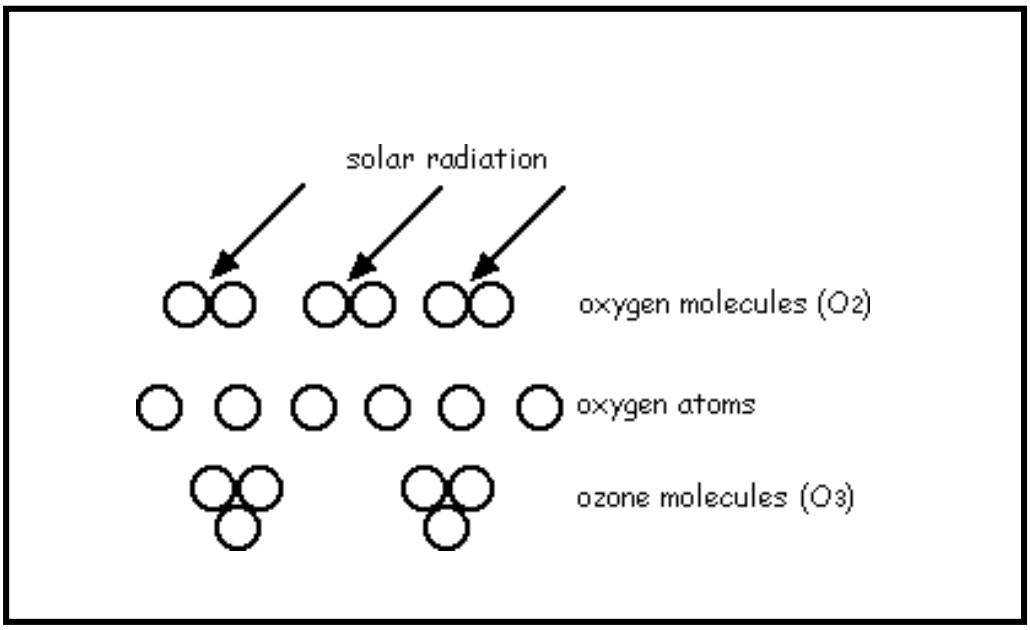
Human and other animal DNA is broken by UV-B light which is absorbed by ozone. Medical expenses would increase dramatically with decreases in the ozone concentration. Skin cancer rates would increase. Veterinary bills and losses to dead livestock would increase and cause economic losses to ranchers. Some crops would be damaged, thereby causing food prices to increase. Truck- ers and people who work outside could be temporarily out of work due to cor-neal clouding. Sales of skin product that block UV-B light would also increase.

- Click "Back" to get back to the OAR Ozone Application site.

B. *Ozone Formation*

- Click on the "Ozone Shield" site.
- Read the "Ozone and Humankind" section.

1. Recall that oxygen we can breathe exists as a molecule of two oxygen atoms bound together (O_2). Draw how three oxygen molecules can turn into two ozone molecules (O_3). Include all three steps and show everything necessary for the reaction to occur.



- Click "Back" until you get back to the OAR Ozone main screen.

V. Enrichment Activities

A. Research

1. Use resources on the Internet to write a report on electric cars. Include how they could help lower nitrous oxide emissions. Include the energy sources we could use to provide power for the cars if we want to use nonpolluting source of energy.

2. Use resources on the Internet to write a report on fuel cells. Include the use of water electrolysis to make hydrogen from water.

3. Research the relationship of ultraviolet radiation to skin cancer.

4. Research the relationship of ultraviolet radiation to cataracts.

5. Find out how ozone is created by lightning.

6. Research the change in the shape of the Antarctic ozone hole every five years since 1957. Draw the change and label each one.

B. Newspaper Activities

1. Collect articles related to ozone and summarize each one.

C. Related Web Sites

1. NOAA's Office of Global Programs Ozone site
   http://www.ogp.noaa.gov/OGPFront/mono2.html
2. Aeronomy lab
   http://www.al.noaa.gov
3. Commonly asked questions about ozone from the Aeronomy Lab
   http://www.al.noaa.gov/WWWHD/pubdocs/Assessment94/common-questions.html
4. Climate Diagnostics Laboratory
   www.cmdl.noaa.gov/